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Recovering the Attitude of the Huygens Descent Module

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Introduction: Data from a combination of DISR and Huygens instruments will allow probe attitude reconstruction during the descent phase. The radiances measured by the DISR Sun Sensor (SS), Side-Looking Imager (SLI), Solar Aureole (SA 1,2,3 and 4) cameras and other DISR and Huygens Instruments (see Table), as they are exposed to different patches of Titan sky and surface while the descent module spins, will be compared to a model of the satellite's absolute sky brightness in order to discern deviations from a baseline simulation with no tips and tilts.

Method: The recovery algorithm is based on the output of software simulators, representing the above instruments, which use the general model of Titan sky brightness to generate synthetic intensities under general conditions of wind velocity, descent and spin rate and parachute sway. The Titan radiative transfer model will be greatly improved by the measurements made by all of the DISR instruments. For the case of zero parachute sway the descent history of sky brightness as generated by the SS, SLI and SA simulators, exposed to this model, constitutes a baseline history which acts as a reference to the case with nonzero descent module pitch and roll. The instantaneous spin axis tilt and tilt azimuth are then altered in a systematic fashion until the error between the synthetic data and the measured data reaches a minimum. The algorithm uses a Simplex optimization routine to drive this minimization. Currently, when modelling this process, the "measured" data also consists of synthetic data because of the lack of real Titan data.

Results: Successful attempts to recover imposed values of spin-axis tilt and azimuth during simulated descents have established the procedure's general validity and will be reported.

Discussion: A Simplex routine has proven superior to routines based on least-squares optimization. Using the simulator automatically compensates, in a most faithful and nonlinear way, for the rather complex azimuthal, meridional and altitudinal variations in sky brightness likely to exist in Titan's sky, leaving residual variations which are largely due to tilt. The method allows convenient use of all useful data. Clouds, or other inhomogeneities in the sky brightness, can be conveniently excluded by simply omitting data from the error function without a significant loss of accuracy, because of the redundant nature of observations. The lack of a visible horizon (as is expected on Titan) does not hinder the data recovery because of the high fidelity of the normalization provided by the simulator. Real variations in intensity will be smoothed and less pronounced certainly, but they will be smoothed to the same degree and direction in the simulated data. Moreover, the radiative transfer model underpinning the simulator may be modified at will to include the effects of inhomogeneities with specific radiative properties at specific locations, if desired. The model automatically adjusts the normalization using the zero-tilt approach.

For Table please download abstract in .doc format